National Park Service
U.S. Department of the Interior

Glacier National Park

Winter Ecology

3rd-5th Grade Field Trip

Preparing For Your Trip

Welcome and Need to Know Information

Dear Teacher,

This packet contains all the information you will need to prepare your students for a winter field trip to Glacier National Park.

- The field trip lesson plan on pages 15-19 should answer most questions about field trip logistics, objectives, and schedules.
- The rest of the lessons are meant to prepare students for the concepts and vocabulary highlighted on the field trip. Each activity can serve as a pre-visit introduction or a post-visit assessment/extension. A suggested unit plan organization is located on the following page.
- Glacier's SmartBoard lessons are a great way to supplement this unit. Learn about the importance of Glacier's snowpack, how to dress for winter, and lots more!
- Visit our **website** for more lesson plan ideas and background information for any field trip. This guide contains only a sample of what is available.

Be sure to confirm the date(s) and meeting place for your field trip (received via e-mail is/are correct). There is no cost for this field trip. A waiver for the park entrance fee has been processed for your class(es). Travel grants may be available to schools with restricted travel budgets.

The education ranger assigned to your group will call you before your field trip date to discuss the schedule and answer any questions. You can also reach them at 406-888-7899.

Our winter education programs are made possible by the support of the Glacier National Park Conservancy. Thank you for introducing your students to the National Park Service Mission and the wonders of Glacier!

Glacier National Park
Education Staff

Glacier National Park
CONSERVANCY

Glacier's Education Goals

- Provide opportunities for the students to form emotional and intellectual connections with park resources and values.
- Introduce students to the National Park Service mission and significances of Glacier.
- Provide curriculum-based, outdoor education experiences that are age appropriate and supplement classroom learning objectives.
- Introduce students to the value of protecting natural and cultural resources for current and future generations and to encourage actions we can all take to be good stewards of this special place.

	Summary	Objectives *Students will be able to:*	MT and Next Generation Science Standards	Materials
Pre-Field Trip ***What is Winter?***	Students learn how the movement of the earth around the sun (as well as the tilt, for older groups) causes the winter season.	• Explain that Earth rotates on its axis and revolves around the sun. • Describe characteristics of each season. • Relate how all places have winter, but winter is not the same in all places	MT.SCI.K-12.4.5...Describe and model the motion and tilt of the Earth in relation to the sun, and explain the concepts of seasons. 5-ESS1-2...Orbit of Earth around the sun...cause observable patterns.	• Drawing paper • Crayons • Pencils • Globe • Flashlight or lamp
Pre-Field Trip ***Winter's Coming!***	Students play a running game emphasizing the ways animals adapt to winter.	• List animal adaptations for surviving winter • Describe survival strategies animals may use in winter • Explain why the subnivean is important in winter	MT.SCI.K-12.3.4...Define adaptation and identify adaptations specific to survival in their environment. 3-LS4-3...For any particular environment, some organisms survive well, some survive less well, and some cannot survive at all.	• Hibernate, Migrate, Resist signs • Optional: large pictures of Glacier National Park Animals
Pre-Field Trip ***Snow Characteristics***	Students measure and compare temperatures at different depths in a snowpack.	• Investigate the insulating effect of snow • Discover tht temperature sometimes varies according to snow depth	MT.SCI.K-12.1.2...Select and use tools including technology to make measurements and represent results of scientific investigations. 3-ESS2-1...Represent data in tables and other graphical displays to reveal patterns that indicate relationships.	• Household thermometer • Shovel • Clipboard • Paper or data collection table • Pencil
Field Trip ***Winter Ecology in Glacier***	Students examine the winter environment and its effects on plants, animals, and people by going on a snowshoe hike.	Vary depending on field trip. Talk to the ranger before your visit for more information.	Vary depending on field trip. Talk to the ranger before your visit for more information.	• Warm clothes • Name tag • Lunch • Adult helpers
Post-Field Trip ***Snug in the Snow***	Students make shoe box models of how small animals live under the snow in winter.	• Name one animal that lives under the snow in winter • Give one reason small animals stay under the snow in winter.	MT.SCI.K-12.3.4 ...Explain cause and effect relationsips between nonliving and living components within ecosystems; and explain individual response to the changes in the environment. 3-LS4-3...For any particular environment, some organisms survive well, some survive less well, and some cannot survive at all.	• *Who Lives in the Snow?* • Shoeboxes • Art supplies • Twigs, cones, evergreen branches • White paper or cotton • Clay/Animal Cutouts

Lesson 1: Pre-Visit

What Is Winter?

Materials:

* Drawing paper
* Crayons
* Pencils
* Globe or inflatable Earth
* Flashlight or lamp

Vocabulary

Rotate, revolve, orbit, axis, tilt, year, seasons.

Method

Students learn how the movement of the earth around the sun (as well as the tilt, for older groups) causes the winter season. This activity uses group participation, demonstrations, and diagrams.

Objectives

Students will be able to:

- Explain that the Earth rotates on its axis and revolves around the sun.
- Explain different characteristics of each season.
- Explain that all places have winter, but winter is not the same in all places.

MT State Science Standard

MT.SCI.K-12.4.5 Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

- A proficient student will describe and model the motion and tilt of the Earth in relation to the sun, and explain the concepts of day, night, seasons, year, and climate changes.

Next Generation Science Standard

5-ESS1-2. Students who demonstrate understanding can represent data in graphical displays to reveal patterns of daily changes in length/direction of shadows, day/night, and the seasonal appearance of some stars in the night sky.

- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth on an axis cause observable patterns. These include day and night and the different positions of the sun, moon, and stars at different times of the day, month, and year. Learn more.

Background

Winter is the season of the longest nights and shortest days. Which means less light and energy get to Earth from the sun. It is also a time of snow, cold and wind chill. Winter solstice (Dec. 21) is the shortest day of the year and the day winter "officially" begins. As the Earth travels around the Sun, different regions get more direct sunlight than others. The tilt of the Earth on

Background, Continued

its axis is responsible for different seasons in the Northern and Southern Hemispheres. In summer, when the North Pole is tilted toward the sun, the Northern Hemisphere gets more direct sunlight and days are longer. In winter, the tilt is away from the sun and sunlight strikes the Northern Hemisphere at a lower angle. The reduced amount of sunlight striking the Earth due to shorter days and angle of the sun causes colder temperatures. Learn more.

Procedure

1. Discuss the differences between winter, spring, summer, and fall that we notice as seasons change. Ask students how the weather is different in each season and why these changes happen. What happens to the Earth to make the seasons change?
2. Show students a globe and have them gather in a circle around it. Put an X on the globe near students hometown.
3. Place a lamp, flashlight, or other light source in the center of your circle.
4. Explain (either by having them actually move or by passing the globe around) that the Earth both rotates on its axis and revolves around the sun.
5. For younger children, it is enough to know that the Earth and sun are responsible for the seasons and the way that heat and light hit us throughout the year changes – causing our seasons.
6. For older students, add that Earth is tilted. Using a flashlight may be helpful.
    - Pass the Earth around the circle having students rotate and revolve it. As they come to each season, talk about how the light and heat is hitting the earth and what some of the characteristics we have of that season are.
    - More details could be added like the tilt of the Earth, the speed of the rotations and revolution, and the distance from the sun.
7. Ask students how many times they have been around the sun (their age). Can they figure out that it takes a whole year to go around the Sun?

Evaluation

Students draw a picture of the Earth and sun. Labelling with an X parts of the Earth where it would be summer and an O showing the parts of Earth where it would be winter. Write 2-3 sentences describing why we have different seasons in Montana. Students should answer the question, “What will the weather be like in Montana next season?” and give evidence about the sun and Earth as justification.

Extension

Have students locate the following places on the globe: Santiago, Chile; Belem, Brazil (at the mouth of the Amazon); and Fairbanks, Alaska. Discuss how weather and seasons would be different in these locations throughout the year.

Lesson 2: Pre-Visit

Winter's Coming!

Materials:

* Hibernate, Migrate, Resist Signs
* Optional: large pictures of Glacier National Park animals

Vocabulary

Hibernate, migrate, resist, subnivean, huddling, yarding, camouflage, predator.

Method

Students play a running game that emphasizes the three main ways that animals adapt to the winter (hibernate, migrate, and resist). They also learn different terms related to winter in Glacier.

Objectives

Students will be able to:

- List animal adaptations for surviving winter (hibernate, migrate, resist).
- List survival strategies animals use in the winter (yarding, camouflage, etc.).
- Explain the word "subnivean" and why it is important in the winter.

MT State Science Standard

MT.SCI.K-12.3.4 Students, through the inquiry process, demonstrate knowledge of characteristics, structures and function of living things, the process and diversity of life, and how living organisms interact with each other and their environment.

- Essential Learning Expectations: A proficient student will define adaptation and identify adaptations in a variety of organisms that are specific to survival in their environment.

Next Generation Science Standard

3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well,some survive less well, and some cannot survive at all.

- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3) Learn more.

Background

To survive winter, animals must migrate (go somewhere else), hibernate (sleep through winter), or resist (put up with the weather). There are many strategies resistors use to survive. Snowshoe hares (and others) use camouflage to blend in with snow. Deer yard, or gather in an area they have stomped down. Smaller animals huddle together to stay warm. For many

Background, Continued

animals, the subnivean (under the snow) is necessary for survival. Mice and voles make tunnels under the snow, using its insulation to stay warm and protected. Learn more.

Procedure

Gather students in an open area to participate. Explain the three main strategies animals use to survive the winter (hibernate, migrate, resist) and the definition of each. Pick a base for each survival method (form a triangle with the bases). Tell students that when you shout one of those terms, they should run to the designated base. Example: teacher yells, "Migrate!" Students run to the migrate base. Have students run to each base a few times so they remember where they are. Add a new action when they hear "Winter's Coming!" They need to freeze no matter where they are (more or less freeze tag rules). If they don't freeze, they are temporarily out of the game (icicles), and should go to the middle of the playing area. Students may not move until they hear "Spring Thaw!" At that point, students may move (students that were out, may move as soon as someone still in the game tags them). Practice adding "winter's coming" and "spring thaw" into the game. Example: teacher yells, "Migrate!" Students run to the migrate base, "Resist!" Students begin running… "Winter's Coming!" Students freeze, those that still run are sent to the middle and become 'icicles.' "Spring Thaw! Hibernate!" Students run to the hibernate base and on the way they tag the 'icicles' to unfreeze them, if they decide to. (At this point they understand the basics and you can start mixing it up a bit.)

1. Once students get the idea of running to the different bases and "winter's coming," start adding other elements. They will work either by themselves or with others to act out different strategies for animal survival in winter. Use any or all of these:
   - Predator - an animal or other organism (such as a carnivorous plant) that hunts and kills other organisms for food. Each student gets down on all fours and pretends to be a predator.
   - Camouflage- to conceal by the use of disguise or by protective coloring or garments that blend in with the surrounding environment. Two students work together to act out a snowshoe hare (one student stands behind their kneeling partner and gives them bunny ears).
   - Subnivean- the area under the snow. Three students work together to act out the idea of the subnivean (two students should form a bridge with their arms and the third student should hunch down underneath their arms).
   - Huddling- to crowd together, as from cold or fear. Four or five students huddle together.
   - Yarding- stay in one location. Four or five students pretend to be deer and stomp down a small area all together.
2. Once they know all of the actions, the three main adaptations (bases), and the idea of "Winter's Coming" and "Spring Thaw," you can yell out the actions and bases in any order (and as quickly) as you choose. Once the game is finished, recap the importance of the different actions and adaptations and why animals choose to do what they do.

Evaluation

1. Students can correctly name the three categories of adaptations animals use for winter survival in Glacier National Park.
2. Students can explain the importance of the subnivean, yarding, huddling, and any other terms that were used in the game.

Extension

Play the game as described above. Instead of saying the word hibernate, migrate, or resist; show a picture or say the name of a Glacier Park animal. Have students run to the base with the correct adaptation for how that animal survives winter.

- It helps to have students think about what each animal eats. For example, most predators (mountain lions, wolves, lynx, etc..) resist because they can continue hunting and getting enough food to stay active and survive in the winter. Animals that hibernate (bears, ground squirrels, frogs, etc..) can't find enough vegetation, insects, or other food necessary to stay active through the winter so they slow down their metabolisms and go to sleep. See the chart on the following page and visit the online Montana Field Guide for more information.

Animals	Adaptation	Winter Habitat	Winter Food Sources
Bats	Migrate/ Hibernate	Caves, mines	
Badger	Resist	Underground dens	Ground squirrels, pocket gophers
Bear, black	Hibernate	Shelter between roots, under fallen trees, in caves	
Bear, grizzly	Hibernate	Digs hole into mountain side	
Beaver	Resist	Pond, lodge door below ice	Bark and twigs, poplar and birch
Bighorn sheep	Resist	Woods and fields	Bunchgrasses and shrubs
Bobcat	Resist	Woods, brushy areas	Rodents
Chipmunk	Resist	Below frost line in burrow	Cached seeds and nuts
Coyote	Resist	Fields and woods	Small or medium-sized animals
Dear, mule	Resist/ Migrate	Lower elevations from summer	
Deer, white-tailed	Resist	Sheltered woods, usually evergreen	Twigs, evergreens, buds, apples
Eagle, bald	Migrate/ Resist	Along water bodies	Fish and other carrion
Elk	Migrate/ Resist	From high elevations to lower	Aspen buds, bark
Fish	Resist	Lakes and streams	Aquatic insects, algae
Fox, red	Resist	Open, timbered, and farmland	Mice, rabbits, insects, fruit, carrion
Frogs, turtles, salamanders	Hibernate	Burrow down into mud	
Harlequin duck	Migrate	Pacific Ocean	
Hare, snowshoe	Resist	Brushy area, woods	Buds, bark, own droppings
Hummingbirds	Migrate		
Loon	Migrate	As far south as Baja	
Lynx, Mountain lion	Resist	Woods and fields	Deer, hares, rodents, coyotes
Marmot	Hibernate	Alpine burrows	
Mice, voles	Resist	Tunnels under snow in fields	Seeds, roots, stems
Moose	Resist	Forests, near water	Twigs, bark, saplings
Mountain goat	Resist	Alpine, wind-swept slopes	Lichens, mosses, grasses, conifers
Muskrat	Resist	Cattail lodge in marsh	Roots, stems, clams, snails, fish
Otter, river	Resist	Near water	Fish, amphibians, crustaceans
Owl	Resist/ Migrate	Meadows where prey is found. Forests	Small rodents
Pika	Resist	Alpine meadows under rocks	Hay stored from summer
Ptarmigan	Resist	Alpine meadows in snow	Seeds and buds
Skunk, striped	Resist/ Inactive	In cavities or holes in the ground	Insects (esp. larvae), small mammals, ground squirrels
Snake, garter	Hibernate	Underground	
Squirrel, ground	Hibernate	Underground burrows	
Squirrel, red tree	Resist	Coniferous woods	Cone seeds, nuts, seeds
All weasel family	Resist	Fields and woods	Small animals, insects
Wolf	Resist	Follows prey	Elk, deer, moose

Lesson 3: Pre-Visit

Snow Characteristics

Materials:
* Thermometer
* Shovel
* Clipboard
* Data Collection Paper
* Pencil

Vocabulary

Insulation, snow crystal, snowflake, condensation, water cycle.

Method

Students take temperatures at different depths in the snow and compare them to the air temperature. Variations for students to see where in the snow gelatin will solidify fastest, and for catching and classifying snowflake shapes are presented.

Objective

Students will be able to investigate the insulating effect of snow and understand that temperature varies according to snow depth.

MT State Science Standard

MT.SCI.K-12.1.2 Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.

- A proficient student will select and use appropriate tools including technology to make measurements and represent results of basic scientific investigations.

Next Generation Science Standard

3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

- Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1)

Background

Snow acts as insulation and provides an environment that has relatively stable temperatures. Small animals (mice, voles and shrews, etc.) spend most of the winter under a protective blanket of snow. Snowshoe hares, grouse, and ptarmigan snuggle into snow, protected from wind and temperature extremes. Large animals (deer, elk, moose, mountain goats, bighorn sheep, etc.) move to south facing slopes, as they are warmer and snow melts off sooner making walking and locating food easier. Temperatures within a snow pack can vary depending on the consistency of the snow. Snow consistency and depth can assist or impede the movement of animals.

Procedure

1. Show students a large picture of a thermometer. Review procedures and be sure everyone knows how to read it.
2. Divide students into teams to take and record temperatures. (Be sure that

Procedure, Continued

all students have a chance to take some of the temperatures).

3. Go outside. Each team uses a shovel to dig a "pit" in the snow at different locations in your test area. Have them take temperatures at the following locations: the air temperature; the temperature at the surface of the snow and every few inches below the surface down to ground level if possible. Have them record their temperatures in a table, like the one below, so that teams can compare their findings:

Depth in snow	Observations of layer -hard, soft, fine, coarse...	Team 1 Temps	Team 2 Temps	Team 3 Temps
Air				
Surface of snow pit				
4 in. below surface				
8 in. "				
12 inches below				

4. Inside, compare temperatures and layer observations. Discuss how the temperatures are the same or different and why. How might these differences affect animals in the winter? Did anyone notice any difference in the snow layers as they took the temperatures? What could have caused that?

Evaluation

Have student groups prepare graphs showing their collected data. Groups can present their information and explain any temperature variations they observed.

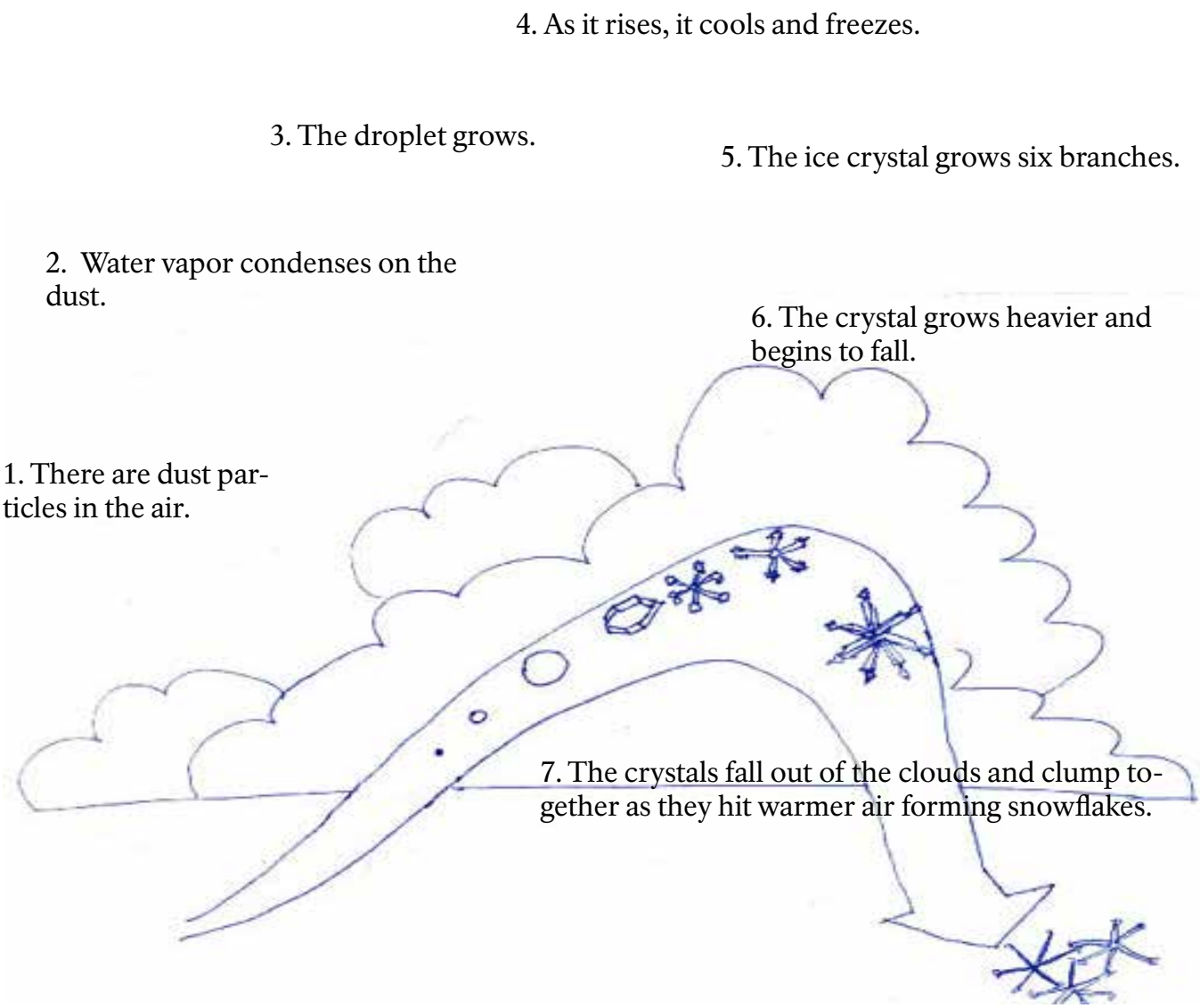
Variation: Place equal amounts of water (or gelatin) in cups with lids and bury one cup in the snow and put the other cup on the surface of the snow. Which freezes faster? Why? (Start with cold water and get it outside early in the day).

Extension

- Is Snow Clean? Collect fresh snow in a clean, empty container. Allow snow to melt. Hold a paper towel or coffee filter over an empty bowl. Slowly pour the melted snow into the bowl. Is there dirt collecting on the filter? A magnifying glass can give you a closer look. Dirt may collect on the filter because every snowflake forms on a speck of dust or salt (see diagram on facing page). As the snowflakes fall, they collect more dirt from the air.
- Flakes Up Close: Take students outside on a snowy day. Give everyone a hand lens. Have students look closely at the snowflakes that fall on their glove or sleeve. Encourage students to share their findings. Check out http://snowflakebentley.com for some great snowflake images.
- Permanent Impressions: Chill a piece of glass (a microscope slide works well) and spray it with chilled hair spray or chilled clear lacquer. Take the students and the sprayed glass (carried on a piece of cardboard) outside. Catch snow flakes on the glass as they fall. They will make imprints on the glass. Leave the slides in the cold until the lacquer dries. Look at the shapes under a microscope. Use the classification guide on the next page to see what shapes your snowflakes are in. You could record how many you get of each type and then find the percentage of each.

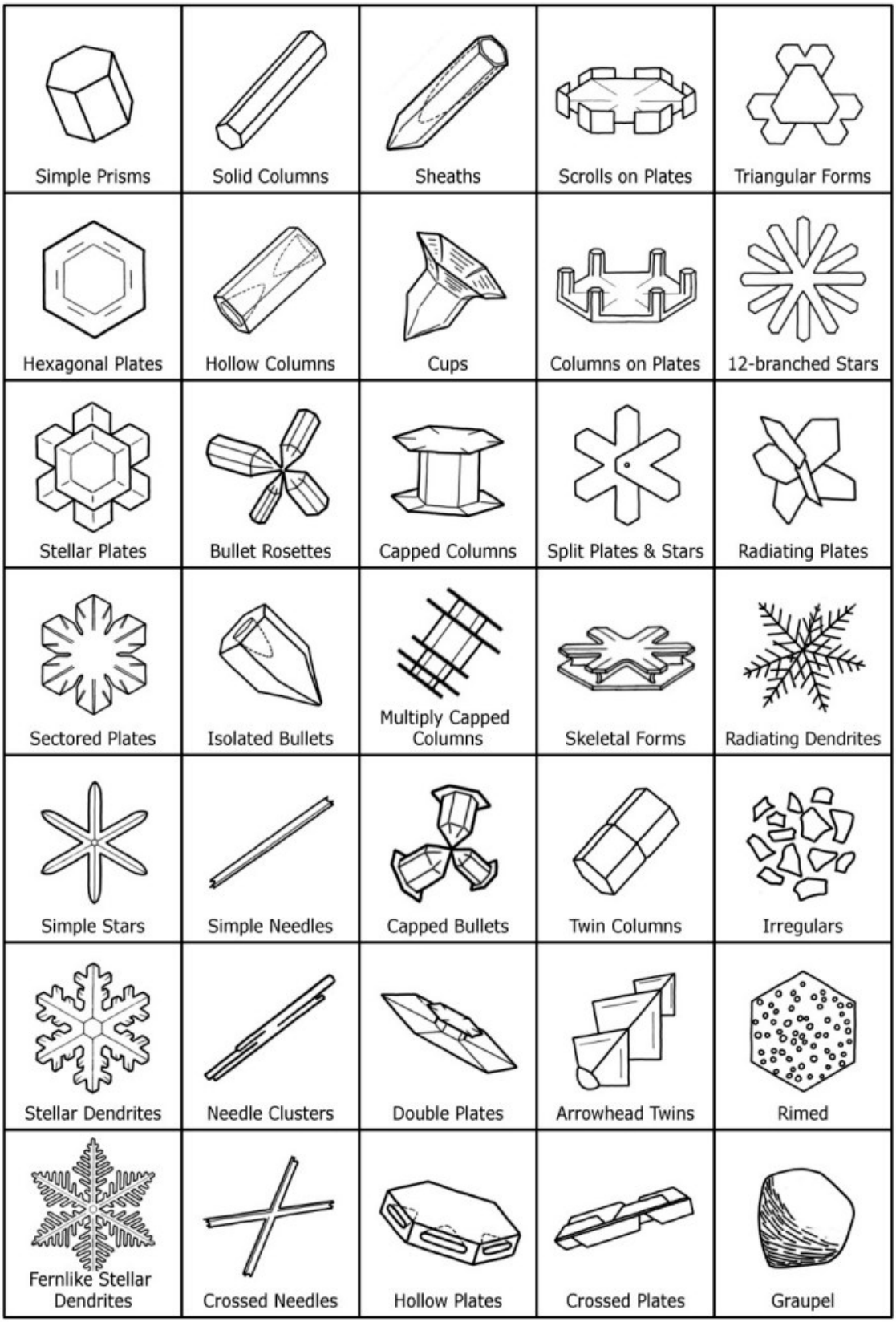
Birth of a Snowflake

from Discover Nature in Winter



Did You Know?

In 1951 the International Commission on Snow and Ice produced a fairly simple and widely used classification system for solid precipitation. This system defines the seven principal snow crystal types as plates, stellar crystals, columns, needles, spatial dendrites, capped columns, and irregular forms. To these are added three additional types of frozen precipitation: graupel, ice pellets, and hail. The classification system in the following pages is one by Libbrecht who has been studying snow crystals for years and prefers a more complex system.



Types of Snowflakes ... SnowCrystals.com

Printed with permission from Kenneth Librecht

Lesson 4: Field Trip

Winter Ecology in Glacier

Remember:

Flexibility is essential for an enjoyable visit to Glacier. Each program is unique but the following represents a typical visit.

Vocabulary

Varies by field trip but may include: national parks, preserve, protect, sun, earth, heat, energy, seasons, winter, snow water equivalent, water cycle, weather, climate, temperature, adaptation, migration, hibernation, resistance, food chain, subnivean, predator, prey, camouflage, insulation, snowpack, habitats.

Method

Students will examine the inter-relationships between living and non-living components of the winter environment by exploring the physical properties of snow at four to five snow stations. They will investigate how those physical properties impact organisms in winter while participating in a one to two-hour snowshoe hike.

Objectives

Students will be able to (depending on grade level and weather condition):

- Tell what national parks protect and why Glacier National Park was created.
- Describe the sun's connection with earth, heat, energy, and food; how it changes during the year; and why it's harder for animals to survive in winter.
- Think scientifically to collect and record snow and weather data by: measuring, comparing and contrasting, calculating snow water equivalent, observing and classifying snow crystals by their properties/ characteristics.
- Explain snow's importance as a natural resource and its role in the water cycle.
- Describe a human adaptation to survive winter used by the Kootenai, Blackfeet, Salish or Pend d'Oreille Indians, whose families originated here.
- Name the snow structure (quinzhee) that originated in the Athabascan Indians as a temporary shelter, describe how to build it, and explain why it is warmer inside than outside.
- Increase heat using their body (run, huddle, put on more insulation, etc.).
- Simulate being a predator or prey and using camouflage to survive winter.
- Dress appropriately to come to Glacier National park in winter prepared to hike independently on snowshoes and follow safety procedures.

Objectives, Continued

- Classify pictures of Glacier animals into groups according to which adaptation they use to survive winter: migration, hibernation, or resistance.
- Compare weather/climate, heat/temperature, and wind chill.
- Create a food chain or web with organisms that stay active in Glacier during winter, including animals that use the subnivean environment.
- Measure, compare, and infer why the snow depth varies along the trail. Discuss how snow depths can help or hurt different animals in winter.
- Relate the basic needs animals must have in order to survive in their habitats to reasons why there are threatened and endangered species in the world.

MT State Science Standards

MT.SCI.K-12.3 Students, through the inquiry process, demonstrate knowledge of characteristics, structures, functions of living things...and how living organisms interact with each other and their environment.

MT.SCI.K-12.4 Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

Next Generation Science Standards

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

While these standards are the most applicable for what we highlight during an education program, there are many other standards that may also apply.

Background

Glacier National Park protects plant and animal habitats and preserves natural processes, like seasonal changes. Glacier provides an undisturbed place to study the relationships living things have with their environment during winter.

Sample Field Trip Schedule

8:30 a.m. – 9:30 a.m. Travel to the Park
Simple assignments can be completed by seat mates or individuals during this time. Point out sights along the way that relate to the park story such as the amount of snow along the route, if they see farm fields or ranches versus cities or forests.

9:30 a.m. – 10:00 a.m. Meet Park Rangers at Designated Site
After a welcome by park rangers to Glacier National Park, the group will talk about the National Park Mission and take a snack/bathroom break.

10:00 a.m. – 11:00 a.m. Snow Stations
Rangers will discuss "What is winter?" and "How do we know that it's winter?" with students. Then chaperones & rangers will lead activities at 4-6 snow stations where students with worksheets and task cards will work in small groups to investigate the physical properties of snow.

11:00 a.m. - 11:30 a.m. Wrap-Up Snow Stations and Eat Lunch

11:30 a.m. – 1:15 p.m. Snowshoe Hike

1:15 p.m. – 1:30 p.m. Snowshoes Off and Bathroom Breaks

1:30 p.m. – 1:45 p.m. Bus Leaves the Park

Station #1 - Weather measurements help us predict and prepare

The National Weather Service uses weather stations with instruments like these to collect temperature and snowfall information from around the country. We use this information to know when it is safe to spend time outdoors and to know how to prepare and dress for outdoor activities.

1. Current temperature = _____ ^{0}F _____ ^{0}C

2. Minimum temperature last 24 hours = _____ ^{0}F

3. Maximum temperature last 24 hours = _____ ^{0}F

4. Wind speed= ____ mph

5. Using the current temperature (#1) and wind speed (#4) you can determine how cold it feels to your body. This is called the wind chill.

Wind chill= _____ ^{0}F

6. Snow pack is the depth of snow that is on the ground. It has been accumulating all season.

Snow pack = ____ inches

Back at School

We hope you had a great time on your field trip to Glacier National Park! We also hope that you learned something about how snow affects the plants, animals, and people who live in and around Glacier. Fill in the blanks below to help you think about what you learned today.

1. If I were an animal, plant or insect in Glacier, I would be a

_____ because then in winter, when it

snowed, I _____

_____

I could also _____

_____

The snow would help me by _____

_____

_____

The snow would make it harder for me _____

_____

_____

My winter life would be _____

_____

Station #3 - Snow is our drinking water source

Rangers in Glacier National Park have been conducting snow surveys for over 80 years. The amount of water in the snow pack is important to people since when the snow melts, it flows into the rivers, streams and down into the ground. It's the water we use for our drinking water!

By measuring the amount of water in the snow pack throughout northwest Montana during the winter, resource managers can predict how much water will be available in the summer for crops, livestock, residents, and businesses. Try it!

Take turns getting snow weight measurements to find the snow water equivalent (SWE). This is the amount of water that would cover the ground if all the snow melted right now.

1. Weight of snow = _____ g

2. Weight of snow ÷ size of cutter = Water in each 1 cm of snow

_____ g ÷ 1000 cm^3 = _____

3. Water in each 1 cm of snow X height of snow = SWE

_____ X _____ cm = _____ cm

Why should we care how much water is in the snow?

_____

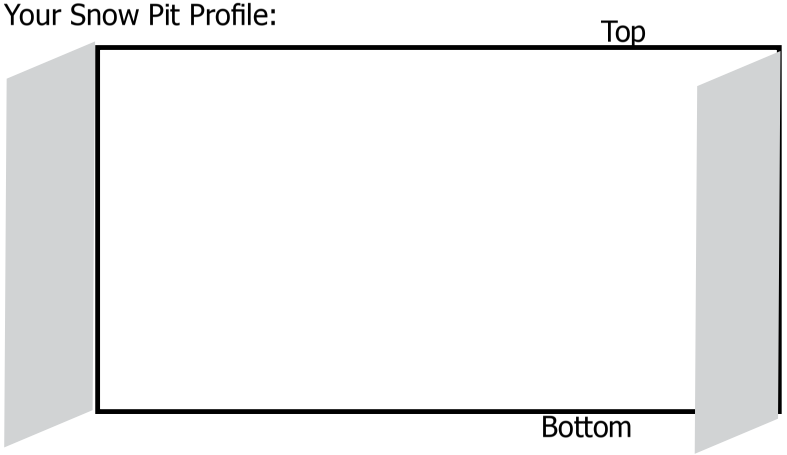
Station #4 - The changing snow pack

Snowflakes on the ground are constantly changing shape because of the temperature, wind, and weight of more snow. The earth naturally gives off heat. This warms the bottom layer of snow and causes the snow crystals next to the ground to grow larger and fit more loosely together.

1. Slide the card through the snow in a line from the top of the snow pit all the way to the bottom.

2. Each time you feel the snow change (get harder, become icy, or get softer) mark it with a popsicle stick. Draw a line across the box below for each stick layer in your table.

Your Snow Pit Profile:



4. How could the changing snowpack affect animals? _____

_____

_____

_____.

Station #5 - Snow and insulation

For many small mammals and insects, the presence of snow cover is very important to their overwintering success. This is because snow is a good insulator - it holds in heat. People have also used the insulating properties of snow to keep warm by building snow shelters.

1. Air temperature outside the igloo = _____ ^{0}F

2. Air temperature inside when you enter = _____ ^{0}F

3. Stay inside and read the story pages from Who Lives Under the Snow? When you're finished, measure the temperature inside the igloo again.

Air temperature inside (after story) = _____ ^{0}F

4. How did all the temperatures compare?

_____

_____

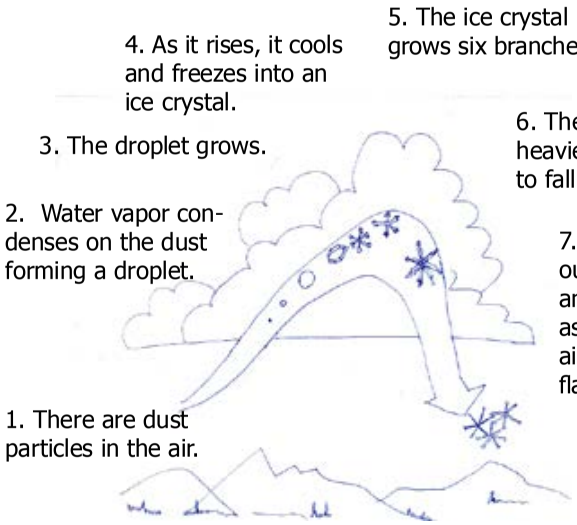
6. What do you think caused the differences?

_____

Did you know?
Scientists have found that with 16-20 inches of snowpack, the temperature at the bottom of the snow (subnivean environment) stays almost a constant temperature, around 32 ^{0}F. Why should we care how much water is in the snow?

_____

Station #2 - What is snow?



1. Use the magnifying glasses to look closely at one snowflake (placing it on a dark background helps).

2. Compare your snowflake to the pictures on the classification chart.

3. Draw 3 different snowflakes you observed.

Snowflake #1	Snowflake #2	Snowflake #3

Did you know?
When you breathe, you're adding moisture to the air?

Protecting the National Park

In order to have a fun and exciting experience, a firm framework of rules should be discussed in advance. The discussion should include the following points:

- Respect both plants and animals in Glacier National Park.
- Harassing animals and picking flowers, pine cones, feathers, and other natural objects in the park are illegal.
- Respecting rights of others in Glacier by refraining from disruptive behavior.
- Respecting each other, the ranger, chaperones, and teachers (walk on trails, keep hands to yourself, wait to talk until the instructor is finished, etc.).

School Regulations and Safety

Teachers are responsible for following school regulations regarding parental permission slips, travel authorization/insurance, etc.. An accident can ruin a field trip and jeopardize future ones. Safety is of utmost importance. Students must be with adults at all times.

Clothing

Remind students to check the weather and bring appropriate, comfortable clothing, including a hat, snow pants, winter coat, gloves/mittens, and boots. Encourage students to bring extra layers and dry clothes.

Name tags

For safety and courtesy, rangers prefer to know students' names. Masking tape with names written in big letters, works well. If you make name tags as a pre-visit activity, be sure they are easy to read and stay on when students are active.

Food and Lunches

Everyone needs a lunch and drink. Re-sealable drinks work best as they can be refilled and saved. No food or drink is available at the park. Students are expected to clean up the lunch area. Food/gum are prohibited except at designated times.

Groups

See the chaperone guidelines on the next page. Typically it works best to assign adults to groups of students before arriving at the park. (A typical bus of 45 students would be divided into nine groups of 5 students each.)

Items to leave Behind

Students should not bring iPods, CD players, radios, cell phones, or money. These items can be lost and may be a distraction. Adults should also leave cell phones at home (or turned off) during the field trip. Cameras and binoculars will not be needed and may only be brought if they will be used at ranger approved times. Designating one adult as the class photographer and asking them to take pictures throughout the day to share with everyone is a great alternative.

Winter Weather and Road Conditions

Check road conditions and weather conditions the day of your program. Webcams can show you and your students weather in Glacier in real time. Call the Education Staff (406-888-7899) with questions. Programs may be cancelled if the day's high temperature, with wind chill, is to be 10°F or below. Sometimes modified programs are an option. Talk with your rangers to find out more.

Chaperone Guidelines and Responsibilities

The chaperone requirements for ranger-led educational field trips to Glacier are (these numbers include the teacher):

- Kindergarten - 2nd Grade = 1 adult for every 3 students (example: 22 students, 8 adults required/allowed).
- 3rd - 5th grade = 1 adult for every 5 students (example: 22 students, 5 adults required/allowed)).
- 6th grade and higher = 1 adult for every 10 students (example: 22 students, 3 adults required/allowed).

Please assist your child's teacher by volunteering to help with a field trip to Glacier, or by respecting their apologies when your help is not needed because it exceeds the park's guidelines listed above. Our facilities, staffing, and resource protection mandate that we limit not only the number of students we can handle per trip, but also the number of adults with each group.

If you are selected to help with a field trip, realize that you are an important partner in our program. We need your participation and cooperation to make the trip a success and will be asking this of you:

Do not bring siblings who are not part of the class. Your full attention is needed to help monitor the students assigned to you that day.

- **Please ride on the school bus.** It makes getting everyone through the entrance station much easier and avoids parking problems.
- **Assist with safety.** It will be one of your primary duties as a chaperone.
- **Be an active participant.** Students will want to participate if you do.
- Provide guidance to students for lunch and clean-up.
- Help set boundaries and provide leadership.
- Guide the learning process and help focus students on the activity or speaker.
- **Please consult with your school administrators about the policy regarding firearms on school sponsored events.** We have never had an injury from a wildlife encounter in over 20 years of conducting school field trips in Glacier. Rangers carry bear spray, first aid kits, and radios and will show the group how to hike and recreate safely while in the park.
- Most importantly go with the flow, adapt, and have fun in Glacier! The students pick up on how you react if you are having fun, they will too!

Sample Evaluation of Ranger

United States Department of the Interior

NATIONAL PARK SERVICE
Glacier National Park
West Glacier, Montana 59936

IN REPLY REFER TO:

Dear Teacher:

Thank you for participating in the education program at Glacier National Park. We hope that the field trip provided your class with an opportunity to better understand the significance of their national park. To help us better prepare for your next visit, please take a few minutes to complete this evaluation of our program. We greatly appreciate your thoughts and comments.

Date of Field Trip:_____

Please let us know how your field trip went with a short comment for each of the items below.

Name of Ranger(s):_____	# Rating
Rangers' behavior and responsiveness to students, teachers, and chaperones was appropriate.	
The ranger-led program was presented in a clear and appealing manner at an appropriate level for the students.	
The rangers showed concern for the safety of the participants.	
Rangers were adequately prepared.	
Program registration and pre-program information/contact was sufficient.	

Additional comments about the program, ranger(s), or pre-visit information:

Sample Evaluation of Teacher

United States Department of the Interior

NATIONAL PARK SERVICE
Glacier National Park
West Glacier, Montana 59936

IN REPLY REFER TO:

Dear_____:

Thank you for participating in the education program at Glacier National Park on _____.

We hope that the field trip provided your class with an opportunity to better understand the significance of their national park. As a follow-up we are sending all participating teachers this evaluation to help you better prepare for your next trip. This evaluation is intended to point out strengths as well as areas that need additional attention.

Students wore name tags and were properly dressed for the day.	
Snacks/lunches were organized for easy distribution and everyone assisted with lunch clean-up.	
There were an appropriate number of chaperones present.	
Chaperone(s) actively participated in supervising students.	
Pre-site class preparation was evident.	
Class behavior facilitated a positive learning environment.	

Additional comments:

Sincerely,

Park Ranger(s)

Lesson 4: Post-Visit

Snug in the Snow

Materials:

* *Who Lives in the Snow?* by J.B. Berry
* Shoeboxes
* Chalk or paint
* Scissors, glue/tape
* Twigs, cones, evergreen needles
* White paper/cotton
* Clay/animal cut-outs

Vocabulary

Subnivean, supranivean, intranivean, carbon dioxide.

Method

Students make shoe box models of how small animals live under the snow in winter. An additional option is to conduct an experiment with gelatin to see if it solidifies faster on top of the snow or under the snow.

Objectives

Students will be able to:

- Name one animal that lives under the snow in winter.
- Students will give one reason small animals stay under the snow in winter.

MT State Science Standard

MT.SCI.K-12.3.4 Students, through the inquiry process, demonstrate knowledge of characteristics, structures, functions of living things, processes and diversity of life, and how organisms interact with each other and the environment.

- A proficient student will explain cause and effect relationships between nonliving and living components within ecosystems; and explain individual response to the changes in the environment.

Next Generation Science Standard

3-LS4-3 Construct an argument with evidence that in a habitat some organisms can survive well, some survive less well, and some cannot survive at all.

- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

Background

Many small animals rely on snow for winter survival. Mice, voles, and shrews live in the subnivean (below the snow) world. They tunnel through snow to feed on seeds and tree bark. These animals' tracks can be seen across the surface of snow. When they are on top of the snow, they are vulnerable to predators such as weasels, hawks, and owls. Many

Background, Continued

of the "mouse holes" seen on the snow surface are actually vent holes to allow carbon dioxide from decaying plants to escape so these small animals don't suffocate. Snowshoe hares and grouse take advantage of the snow by snuggling into it for protection from cold and winds.

Procedure

1. Read the story "Who Lives in the Snow?" by Jennifer Berry Jones. Discuss the animals students may already know about like deer and elk that resist and stay active in Glacier National Park all winter. How do they stay warm all winter (thicker coats, moving to sheltered forested areas, etc.). Discuss how for smaller animals who have a harder time keeping their bodies warm, living under the snow provides extra warmth.
2. With older students, review the following vocabulary words for snow with your class: subnivean (below the snow), supranivean (above the snow), intranivean (within the snow), predator (hunts and kills other animals for food), prey (animals killed by predators for food), and insulation (material or combination of materials which retard the flow of heat).
3. Ask students if they have heard the saying "a blanket of snow." What does a blanket do? Tell students that you are going to make models of how small animals live under the snow in winter.
4. Have students lay a shoebox on its side and whiten the inside with chalk or tempera paint.
5. Cut away the roof and replace it with a piece of white paper or cotton cut to size (styrofoam could also be used). Allow paper or cotton to extend about 1/4 to 1/2 inch beyond the surface it is replacing. Hold it in place with toothpicks, tape, or glue.
6. Decorate the top with twigs, dried weeds, and bits of evergreen.
7. Make animals out of clay or play dough and place them where they belong, either above or below the snow. Option: You may use the line drawings provided at the back of this guide for the students to color, then place them where they belong in the diorama.

Evaluation

Ask the students to pretend they are one of the characters in their diorama and have them write a story about life in a subnivean world. Is it dark/light? Cold/warm? Quiet/noisy? Cozy/lonely?

Extension

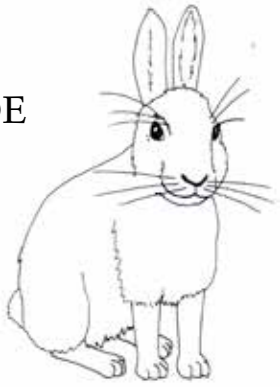
Stir until dissolved, one tablespoon of gelatin into one cup of hot water, then fill film canisters half full and cover them. Divide students into small groups and ask them to choose a shady, exposed area for one canister, and a deep snow place to bury the other canister. Mark where the canisters are buried and make sure they are labelled. You may want to place thermometers next to each. When the surface ones begin to gel, check the buried ones. Which ones gelled first? Check the thermometers and see how they compare. Why might small animals want to stay under the snow on a cold day?

Animal Card Drawing Page

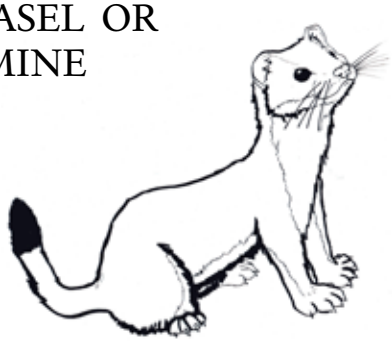
WHITE-TAILED DEER

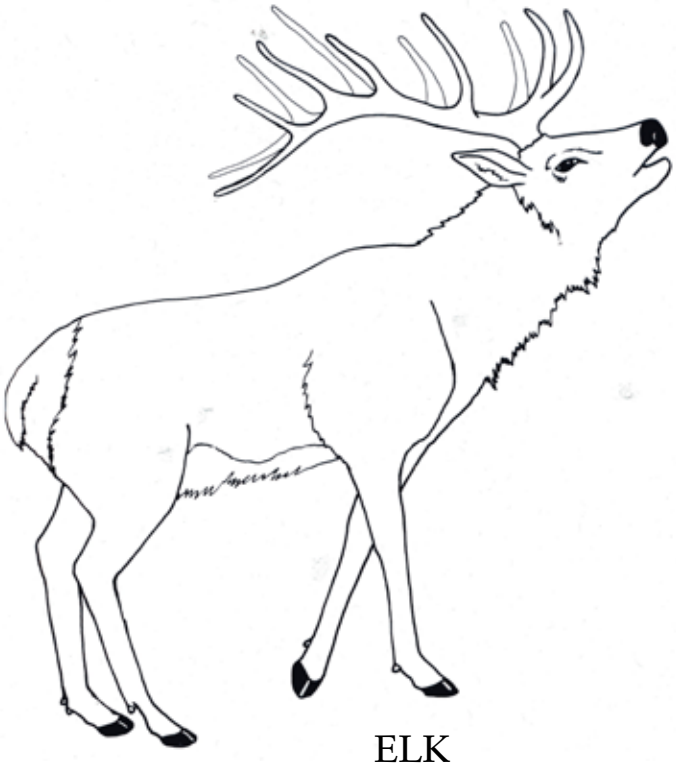
TREE SQUIRREL

SNOWSHOE HARE



SHORT-TAILED WEASEL OR ERMINE

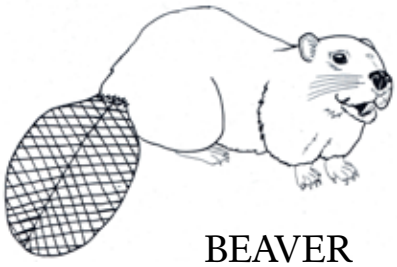




ELK

MOOSE

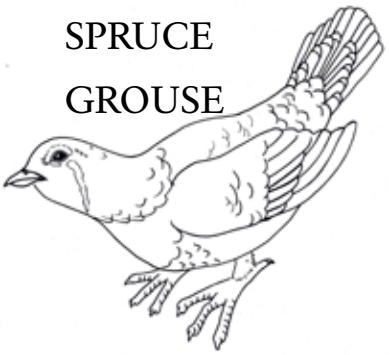
Animal Cards Drawing Page

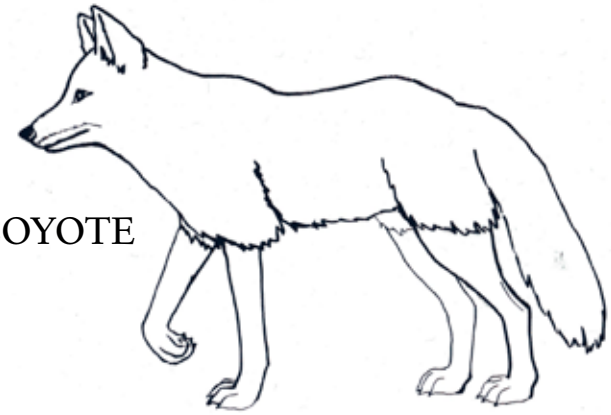


BEAVER

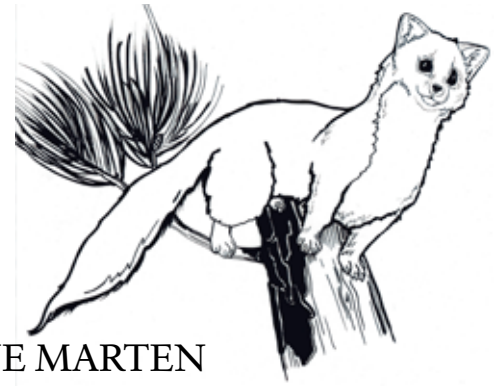
MINK

SPRUCE GROUSE



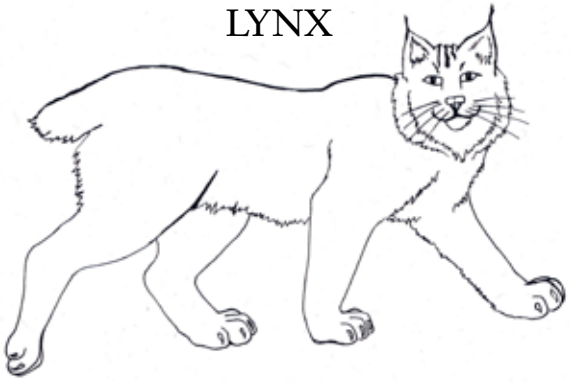


COYOTE

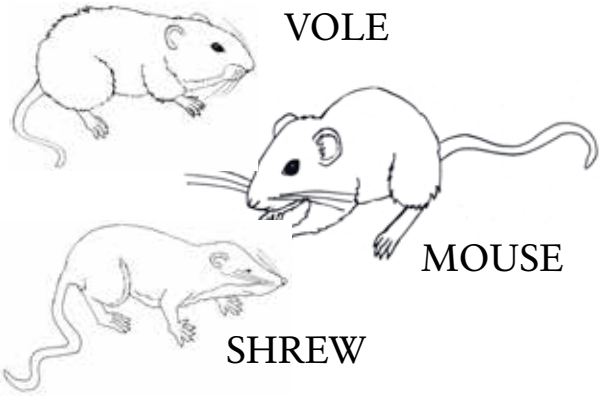


PINE MARTEN

LYNX



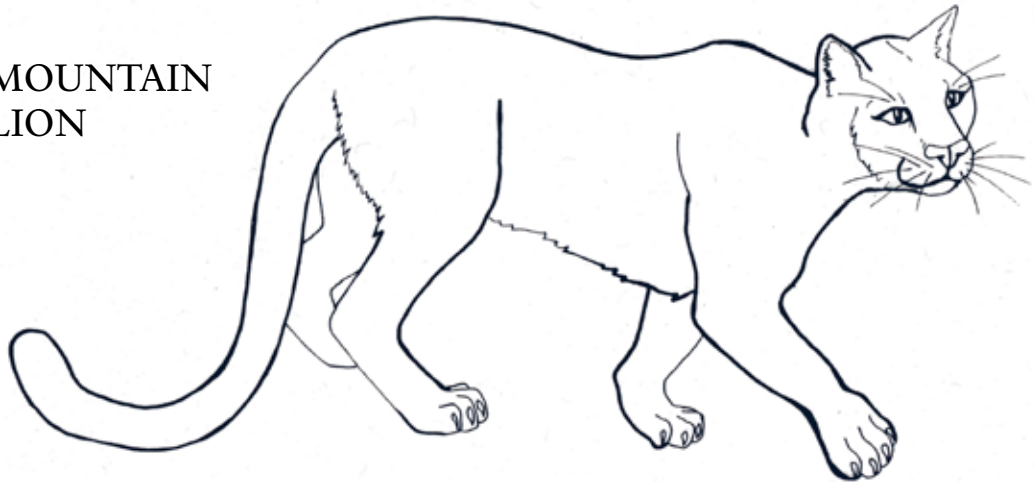
VOLE



MOUSE

SHREW

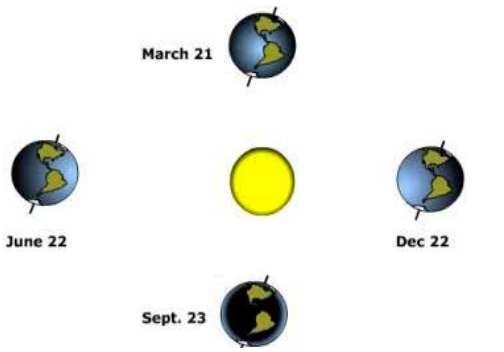
MOUNTAIN LION



Teacher Resources

Additional Background Information

What is Winter?
Winter is the season of the longest night, the shortest day, the least light, as well as the presence of snow, cold and wind chill. It is the slowest growing season for plant life. Food supplies dwindle and it is a hard time for animals. Winter poses many challenges to plants and animals. Winter Ecologist, James Halfpenny, refers to these challenges as the SCREW factors: snow, cold, radiation, energy, and wind. In northern **latitudes** winter is the longest and most difficult season of the year. **Temperature**, snow depth, snow density as well as the duration of winter (a deep snow pack and late season snow extend the winter season) determine the severity of winter and play a role in how many animals survive. Many animals will die during winter. **Winterkill** refers to the combined effects of bad weather, malnutrition, starvation, disease and predation. Winter is a time for economy: food is scarce and energy must be conserved. It is truly a time of survival of the fittest.



Winter solstice (December 21) is the shortest day of the year and the day winter "officially" begins. Interestingly enough, the earth is actually closer to the sun in winter (see diagram) not further away.

What Causes Winter?
As the earth travels around the sun, different regions receive more direct sunlight than others. The tilt of the earth on its **axis** is responsible for the different **seasons** in the northern and southern **hemispheres**. In the summer, when the North Pole is tilted toward the sun, the northern hemisphere gets more direct sunlight and the days are longer than during spring, fall and winter. In winter, the tilt is away from the sun and sunlight strikes the northern hemisphere at a lower angle. Latitude is what determines both the length of the day and the angle of the sun (Waterton/Glacier International Peace Park is pretty far north and straddles the 49th parallel along the Canadian border). The amount of sunlight striking the earth's surface (**solar insolation**) and the length of the day are determined by the position of the sun in the sky. The reduced amount of winter sunlight striking the earth due to shorter days and angle of the sun causes colder temperatures. As the land and its air mass cools, surface waters turn to ice and **precipitation** freezes to cover the land with snow.

At northern latitudes and in mountainous terrain, winter comes early and stays late. At higher **elevations** the **atmosphere** is thinner and holds less warmth. Consequently, it's colder, snow lasts longer, and the length of the growing season is greatly reduced. Elevations in Glacier range from less than 3,200 feet in the Lake McDonald valley to 6,646 at Logan Pass, to more than 10,000 feet on the tallest mountains in the park. In Glacier National Park, the seasons are jokingly referred to as "June, July, August and winter." There is some truth to this as the high country may be snow-free for only about 3 months of the year. It is not unusual to see visitors skiing at Logan Pass in June and occasionally even into July. Winter lasts a long time throughout most of the park.

It is worth noting that since the **Continental Divide** runs through the middle of Glacier National Park, the weather on the west and east sides of the park are different. The west side is

greatly influenced by Pacific Northwest weather patterns. These weather systems provide more rain, milder temperatures and (generally) moister snow than the east side receives. The east side of the park is influenced by continental weather systems characterized by less precipitation and strong, gusty winds. During winter, cold fronts moving down from Siberia and Alaska through Alberta along the **Front Range** can flow over the passes and settle in western valleys. Sub-zero temperatures can last for days or weeks. Eventually, a warm moist Pacific air mass will move in. As it moves over the mountains, the moisture condenses and precipitation occurs. The process of **condensation** releases heat that was stored in the moisture-laden air (thus the east side of the mountains is warmer than the west side at the same elevation). As this warm air moves down the east slope, it picks up speed and creates winds that can exceed 80 mph. These warm winds are known as a **"Chinooks,"** an Indian word for "snow eater." Chinooks can cause temperatures to rise from below zero to above freezing within hours.

Snow

Snow has many different "personalities" depending upon how much water, ice, and air it contains. Snow with high water content can easily be formed into snowballs. Powder snow is so fluffy and dry that it's nearly impossible to pack. Temperatures and wind can affect what happens to snow after it falls. It can be a light fluffy layer or it can harden into an icy surface. Snow crystals not only change as they fall through the air, but they continue to change within the snow pack over time, in a process know as **age-hardening.**

Let's consider the water content of snow first as this is an important resource for people. Rangers in Glacier National Park have been doing Snow Surveys to measure the amount of water in the snow pack for over 80 years. Snow surveys in the West date back to the early 1900s and the Department of Agriculture's cooperative snow survey program for predictions of meltwater runoff. This program is a federal, state, and local partnership directed by the Natural Resources Conservation Service or NRCS (http://www.nrcs.usda.gov/feature/highlights/SnoServ.html). To find out how much water will be available in summer, snow surveyors from NRCS and the other cooperating agencies collect data from some 1,600 snow courses several times each winter. They determine the depth and the water content of the snowpack and estimate the amount of runoff from the mountain watersheds. The information collected by the snow surveyors (and the automated telemetry system) is translated into water supply forecasts that NRCS State offices issue monthly from January to June in cooperation with the National Weather Service. Major sectors of the Western economy- agriculture, industry, and recreation- base their plans on these forecasts. Since Triple Divide Peak in Glacier National Park divides water flowing to the Columbia River Drainage (1), Hudson Bay Drainage (2), and Missouri River Drainage (3), the amount of snow that falls here (and its cleanliness) is crucial for people living in those three watersheds.

Now let's consider how temperature affects snow and thus animals. Fallen snow is not always the same temperature. When the bottom layers of snow are much warmer than the top layers, water vapor creates a bottom or in-between layer that is granular and resembles sugar. This type of snow allows small animals like mice, voles and shrews to readily tunnel through it. Because it contains a lot of air it also is good insulating snow for grouse to hunker down in on a cold night. Animals that paw through snow like moose, deer and elk can easily uncover grasses.

But air temperatures and wind can also alter snow crystals over time to form a hard, compacted snow mass with an even temperature throughout. This type of snow is difficult for mice to burrow through. (Yet, this same snow allows snowshoe hares and deer to reach up higher in shrubs and trees in search of food.) Compacted snow such as this can cause a build-up of carbon dioxide in the lower layers as a result of decaying vegetation. Many of the small "mouse holes" seen on the surface are actually vent holes that allow carbon dioxide to escape. Without them, mice and other **subnivean** (under the snow) dwellers could die.

Why does temperature affect snow this way? Melting and refreezing changes the physical characteristics of the snow. It causes snow crystals to reshape and form a very solid layer. The strength of the snow varies, depending upon whether it is in the melt or freeze stage. Some animals can travel on the surface, while others not as well adapted, will fall through and flounder, becoming easy prey for **predators**. An icy crust allows small animals to move with ease, but may cut a deer's legs, allowing bacteria and infection to spread in an animal already in a weakened condition.

What about the depth of the snow? How does that affect wildlife? When snow gets deep, deer will **yard up** (stay in one location) since bounding through snow requires a lot of energy. Deer have such small feet in relationship to their size, they sink through snow. By yarding, they pack down a network of trails that permits them to reach areas containing winter food. At the same time, there are risks associated with it. During long, hard winters, there is the risk of **overbrowsing** their winter range. And there is an increased risk of spreading diseases when many animals are confined to a relatively small area. Moose and elk can "plow" through deep snow. Moose are especially well adapted for it with their long legs. However, moose will frequently follow already established trails, while elk tend to follow in trails made by a strong lead animal. These modes of travel are known as **trailing**, and they are a means of reducing energy output. Many other animals take advantage of already established trails. Even snowshoe hares establish trails or "bunny runs" as they travel to and from their feeding areas. By using trails, winter animals can help minimize their energy output.

The depth, density and hardness of the snow can help or hinder animals depending upon the situation. A build up of snow on branches of trees may break and snap or bend young trees. Heavy snow on trees can restrict tree travel for pine martens and squirrels, making it more difficult to catch prey or to escape predators. Willows and alders bent by the weight of heavy snow provide food and shelter for snowshoe hares. Where the branches of spruce and fir catch falling snow, the snow depth becomes unequal on the forest floor. In open areas snow is deeper than beneath trees. Trees with full crowns collect most of the snow on branches. The small amount that reaches the ground quickly melts or evaporates leaving a "snow shadow" or **tree well**. Many small animals avoid tree wells during the coldest part of winter since they offer little insulation or protection but if the branches are heavy enough with snow and press close enough to the ground, wind breaks are formed and tree wells become cozy hideouts for animals like snowshoe hares. As winter merges into spring, tree wells are the first places that juncos and other returning birds search for food.

How Do Organisms (living things) in Glacier Survive Winter?
Adaptations: Migration, Hibernation, Resistance (Toleration)
Organisms, or living things, all have adaptations - structures or behaviors that help them to survive in their environment. Winter ecologists classify organisms according to how they experience winter and how they have adapted to it over time. The commonly used system based on the Greek work "chion" for snow has three levels: **chionophobes=** "snow fearers" have been unable to adjust to life in the snow and are usually found in warmer regions (black vultures, palm trees); **chioneuphores=**"snow tolerators" have adjusted their life to winter and can survive but have no special adaptations (shrew, red vox, vole); **chionophiles=** "snow lovers" possess definite adaptations for life in winter and whose geographic distribution is generally limited to winter-dominated regions (spruce tree, mountain goat, snowshoe hare, ptarmigan, and weasels).

An even more basic classification system for how animals cope with winter is based on their main adaptation strategy for winter survival: **migration**, **hibernation**, or **resistance**/toleration (Marchand, 1996). Basically, living things either leave to find an area that is more suitable for them in winter (migrators) or they stay and are not active (hibernators, or organisms that have periods of torpor), or they stay and are active (resistors/tolerators). The following is generalized information about how different groups of organisms deal with winter.

Plants in Winter
By the end of summer or early autumn many plants have died back. **Annuals** will have produced seeds that have fallen to the ground and will germinate next year while the "mother" plant dies. Other seeds, housed inside plump, juicy berries will be eaten by birds, bears or other animals. Since the seeds are not digested, they will be "planted" in new locations within the droppings of these animals. The stems and leaves of **biennials** will die their first winter, but their roots will remain alive while the second year plants produce seeds to ensure survival. **Perennials** die back to the ground each year, but their roots live through winter and the plant will grow back each spring.

The leaves of **deciduous** trees and shrubs change color as daylight hours wane. Soon the leaves will be shed. Lowered temperatures will retard plant growth. **Leaf scars** are sealed with a corky layer and next year's **buds** are covered with scales to conserve moisture. Winter is similar to drought as water is unavailable when it is frozen as ice or snow. Woody shrubs and trees survive the winter in a state of **dormancy**. Evergreen trees and shrubs have thin or small needle-like leaves with waxy coatings to conserve moisture.

The conical shape of many **evergreen** trees makes them more resilient to heavy snow loads. Since their branches slope out and downward, the weight of snow pressing down allows snow to fall off. If enough snow falls from the branches it can pull the branches until they touch the ground and make a wall of snow and branches around the base of the tree. These tree wells can become shelter for wildlife out of the wind. Evergreen trees will photosynthesize at the first available light in spring.

Insects in Winter

Just as many plants go through a resting phase in winter, many insects time their particular life cycle stage best suited to withstand cold, drought-like conditions and lack of food. During this time, activities and/or development discontinue until conditions become favorable in spring. Individual species of insects overwinter at different stages of their metamorphosis.

Douglas Fir Beetle Larvae in Gallery

Insects comprise the base of the food chain and the absence or presence of their populations has a large effect on food availability for other organisms. Chickadees feed largely on insects and have the ability to hang upside down on branches to look for insects hiding on the undersides of leaves and branches. It is interesting to think about what happens to insects, an important food source in winter.

Insects that have incomplete metamorphosis (egg, nymph and adult) usually overwinter in the egg stage. For insects that develop through complete metamorphosis (egg, larva, pupa and adult), the egg and pupa are the most likely stages for overwintering since they are immobile and they have a protective coating that helps them withstand the cold. But some insects like the woolly bear caterpillar overwinter as a larva. The woolly bear stops eating in late summer and finds a sheltered place under leaves and grass. In spring, it forms a cocoon and emerges as an Isabella moth.

Woolly Bear Caterpillar (larval stage)

Insects that overwinter as adults usually find a sheltered place: under leaves, in crevices in trees, under bark, rocks, plants, in buildings, or they descend into the ground and remain dormant. Staggered timing of life cycles ensures that food will be available when they reach the eating stage. Insects react to cold temperatures by slow, stiff movements and a lowered metabolic rate. They lose a high percentage of water and produce glycol, a substance that acts as a kind of antifreeze. We think of these organisms as hibernating to avoid winter, but they actually have complex strategies to resist severe cold stress. On warm days adult insects move around as their bodies warm up sufficiently. The table on the next page lists some of the common insects and their overwintering strategies.

How and Where Some Insects Over-Winter

Insect	Species	Overwintering Stage	Special Preparation	Active or Inactive	Where?
Ants	Carpenter	Adult	Produce glycerol	Inactive	In trees or logs
Aphids	Most	Egg	None	Inactive	In bark crevices or base of twigs
Bumblebees		Queen	Pre-fertilized eggs inside queen	Inactive	Underground, under leaves or logs
Butterflies	Monarch	Adult	Migrate	Semi-active	Mexico or CA
Butterflies	Painted Lady	Adult	Lose body moisture	Inactive	Under bark
Butterflies	Swallowtails	Pupa	Form chrysalis	Inactive	Attached to stems or on the ground
Crickets	Most	Egg		Inactive	In the ground
Dragonflies	Some	Egg		Inactive	On the bottom of a pond
Dragonflies	Some	Nymph		Semi-active	On the bottom of a pond
Flies	Cluster & House flies	Adult		Inactive except when warm	In crevices of buildings or cracks in hollow trees
Grasshoppers	Most	Egg		Inactive	In the ground
Beetles		Larva (grubs)		Inactive	In the ground
Honeybees		Adult	Store food	Semi-active	Hive in a tree or man-made box
Ladybug	All	Adult	Cluster together	Inactive	Under leaves and grasses

Galls

Galls form when insects lay their eggs on plants. A swollen lump on the stem or leaf of a plant may be a gall. Galls can be a variety of sizes, shapes, and colors, some up to the size of a baseball! Most galls form on plant leaves but they can also form on branches, twigs, buds, flowers, fruits, and even roots. Some insects lay their eggs on the plant surface and others make a hole in the plant and insert their eggs inside. Not everything is known about gall formation but in response to the egg-laying, the plant either produces new cells or enlarges existing cells around the area. The newly formed gall provides some protection to the insect eggs (and larvae when they hatch) from the sun, wind, rain, and predators, but not fool proof. There are other insects that invade galls looking for food. Winter is a good time to look for galls since there are fewer leaves on plants.

Animals in Winter
Hibernation
Animals that spend the winter in Glacier National Park are either active or dormant. Dormancy ranges from short periods (**torpor**) to long periods **(hibernation**). Skunks and badgers, for instance may undergo periods of torpor as an energy saving measure during times of extremely cold weather. Hibernators generally sleep through the winter although they may awaken and move around. Hibernation can be defined as a physical state where an animal's body functions slow down in order to conserve energy through a season of no food and water, and cold temperatures. The extent to which the metabolism slows in order to be considered a "true hibernator" is debatable. Hibernators such as Columbian ground squirrels and marmots have drastically reduced body temperatures. A ground squirrel's temperature may drop to 39 degrees Fahrenheit compared to its usual 90 degrees Fahrenheit temperature. Reduced temperatures slow other processes so pulse and respiration rates drop. Breathing may be once every 4 to 6 minutes. At this slow pace, a minimum of energy is expanded and the animal's fat layers can usually meet their slight demand. Many hibernators also curl up into a ball to conserve heat. Ground squirrels and marmots therefore, are considered "true hibernators."

Whether animals, like bears and chipmunks, hibernate or not depends on your source and definitions. Living things do not follow definitive rules. Thus, there is a continuum between the "true hibernation" of ground squirrels and marmots in which all bodily functions are greatly slowed, the deep sleep of bears and chipmunks, and the occasional sleep of raccoons and gray squirrels. Hibernation is the extreme end of the continuum. Bears are said to not truly hibernate because although their bodily processes are slowed, they do not have the reduced body temperatures of other "true hibernators." But bears develop thick coats of fur and have less surface to mass ratios than smaller hibernators so they stay warmer. Bears' metabolism drops by half and their digestive system tightens into a knot, with the limited waste products reprocessed into the bloodstream in the form of proteins. Bears, if not true hibernators, are certainly close. Bears sleep for months without eating, drinking, urinating or defecating. It has been said that while bears may not be true hibernators, they are "digestive hibernators" (www.bobpicket.org).

Migration
When we think of migration, we generally think of birds. Some of the birds that spend summers in Glacier may fly hundreds or even thousands of miles to their wintering area. As birds migrate to warmer climates, they alter their food source and wait for spring or summer to return to their home territory. These amazing migratory treks vary in length; some may span the length of the globe. **Day length** is believed to be the major factor in telling birds it's time to move on. Winter in Glacier National Park is difficult. The food supply has diminished, the length of day and the time in which to locate food is reduced and the amount of energy needed to stay warm is increased.

While 92 birds are listed as common residents of Glacier in summer, only 28 birds are listed as common winter residents (see Glacier National Park Bird Field Check List 1990 in reference section). The Clark's Nutcracker is an example of a bird that migrates from its summer home up in the mountains to lower elevations during winter.


Clark's Nutcracker

Cold, wind, and blowing snow of the high country offer challenges greater than most animals can adequately cope with. For animals that remain active during winter, lower elevations offer easier access to food and more protection from the elements. Animals that move from areas of higher elevations to those that are lower with less snow and more food are considered "altitudinal migrators." Elk and mule deer are two other examples of animals that move from higher elevations in summer to lower elevations in winter.

While migration may seem like an easy option, it places a major strain on these animals. Huge energy reserves are required to make these seasonal journeys and migrators often face competition with native species once they arrive at their wintering site.

Resistance (or Toleration)
To many animals, winter means staying and enduring the challenges of the season and resisting its stresses. Because many organisms cannot simply flee from the cold Glacier winters, they have found numerous ways to survive the harsh climate. There are many fascinating adaptations in the animal world that help them resist winter's hardships.

Birds that resist winter stresses have numerous techniques for survival. When temperatures drop, birds will fluff out their feathers. Feathers are good **insulators**, and fluffed out feathers create a thick layer of stable air around the body. Many small birds **huddle** together at night to reduce heat loss. Others **roost** in tree cavities. Grouse hunker down in deep snow on cold nights, and a scaly projection on their toes helps them to walk on snow. Some birds, including grouse, will store large quantities of food in their **crops** late in the day to carry them through cold winter nights. Gray jays are known to store food on branches of trees or on the ground. Chickadees have an amazing ability to hang upside down on branches as they search for insects. This maneuver allows them to locate food when the upper surface of branches is snow covered. And woodpeckers continue to feed on insects deep within trees.

High in the alpine, the pika will remain active all winter in its den hidden among rock-slides. It will feed on "hay" made up of grass that was cut, dried and stored during summer. It has distinctive adaptations that allow it to survive the long and extreme winter conditions. Its small round ears lay flat along its head; an inconspicuous tail and short legs reduce surface exposure and heat loss; and fur insulates the soles of its feet and provide good traction. Pikas may look like rodents but they are related to rabbits.


Pika

Mountain goats are the largest mammals remaining active in the high country year-round. Their heavy wool **undercoats** and long hollow **guard hairs** provide protection from the cold and wind. Mountain goats can subsist on **lichens** and **mosses** if they cannot find adequate browse. In winter goats move to more south or southwest facing slopes where the winter sun melts snow more quickly and prevailing winds blow the snow away, exposing lichens and vegetation.

The Ptarmigan is the only bird that remains at or above treeline throughout the winter. This alpine cousin to the grouse changes its brown plumage to white as autumn light diminishes and winter snow begins to blanket the mountains. Feathered feet act as snowshoes which allow it to walk on snow. Sharp claws help it to scratch for food beneath the snow. Ptarmigan will feed on willow buds and the needles of subalpine fir. Warmth and protection from winds and sub-zero temperatures is attained by diving into the snow.

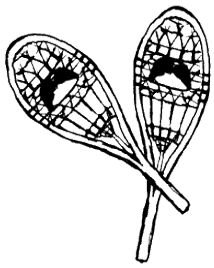
Prior to the actual onset of winter, animals that resist winter stresses have physiological responses that are cued in by the reduced daylight hours. Less daylight trigger a response that is registered in the "master control" gland (**hypothalamus**) in the brain. The hypothalamus then secretes **hormones** that activate other systems throughout the animal's body. Animals react in various ways. Moose, elk and deer begin to **rut**. The interval between the mating season and giving birth ensures the young will be born in the spring when food is abundant. Another reaction to shorter days is the urge to eat more thus building up layers of fat that will help animals make it through winter. Beavers and red squirrels **cache** extra food. Animals that remain active all winter will grow a thicker coat of fur. Deer, elk and moose have **winter coats** comprised of hollow hairs that trap air for better insulation. Other animals develop thick **undercoats**.

Snowshoe hares, weasels and ptarmigan in Glacier National Park turn white. The absence of the pigment melanin, means there are more air spaces within the hairs and thus it has greater insulation value. Snowshoe hares' white winter pelage has 27% better insulating qualities than the summer brown coat. **Photoperiod** triggers hormonal changes that are also influenced by cold and snow. These hormones cause changes in hair color. Weasels undergo a complete molt. Each hair is lost and a new white hair replaces it. Only the tip of the hair turns white on snowshoe hares, while the base remains gray. Timing is critical. A white snowshoe hare or weasel (ermine) makes an easy-to-spot target for a predator. Snowshoe hares as their name implies, have snowshoes: extra fur on the bottom of their large feet in winter helps distribute their weight so they can move on top of the snow with ease.

For animals that remain active in winter, snow is a mixed blessing. It can offer shelter and protection. Snow acts as insulation, holding in earth-warmed air and keeping out cold air. Snow creates a stable environment beneath it (**subnivean** layer) in which temperatures may range from about 20 degrees Fahrenheit to 30 degrees (F), while air temperatures can fluctuate from 30 degrees (F) below zero to 45 degrees (F) above zero. The subnivean world allows plants, insects and animals to escape from temperature extremes and wind. This is important for small animals like mice, voles and shrews. Since their body surface is large in proportion to their size, they lose heat rapidly and it takes considerable time (and energy) to replace it. Their small size does not allow them to carry a thick enough coat to withstand continual exposure to cold. The bark of trees and shrubs, seedheads from plants flattened by snow, and leaf litter/detritus provide much of the food for these small insects and animals. The tracks of mice, voles, and shrews indicate they do spend time on top of the snow (**supranivean** layer) in search of food but these forays can make them vulnerable to predators.

Humans in Winter
Although humans today do not have the capability of hibernating like bears or marmots, we are able to migrate or resist. Native Americans had many strategies for dealing with winter. They built shelters to protect themselves from the cold and wind. They had elaborate systems for obtaining and making warm clothing and for caching and storing food to last throughout the winter. They changed their behavior in winter to conserve energy. Some groups followed seasonal animal migrations in order to have access to more food or shelter from the wind during the winter months. Today, humans are still building shelters to protect ourselves from the cold. Modern clothing can still be found made of animal furs, feathers (down) and plants (wool and cotton), but also from materials like polypropylene or capilene. The infamous "snow birds" from the northern states (and Canada) move in droves in December to warmer climates and remain there until the end of winter.

Snowshoes
The use of snowshoes dates back over a long period of human history. Archaeologists estimate that the first "foot-extenders" used for easier snow travel originated in Asia about 6,000 years ago. Eskimos living in arctic regions did not require the use of snowshoes since most of their travel occurred on wind packed snow or on sea ice. For Native Americans living in forested temperate areas, snowshoes were a necessity for getting around in the winter. The Athabascan Indians of the American and Canadian west coat and the Algonquin Indians of the Ottawa and St. Lawrence River valley areas brought the snowshoes to perfection. Before horses were introduced to America by the Spaniards, the Plains Indians used snowshoes to hunt buffalo.



During the period of westward expansion, snowshoes were just as important as the axe and flintlock rifle in areas where snow was deep throughout winter. Trappers, hunter, explores and surveyors in these areas couldn't be without them. Perhaps the first snowshoes came about when someone watched how easily the snowshoe hare and lynx could travel across the surface of the snow. These animals have very large feet in relation to their body size. Bigger feet allow an animal to spread its weight over a larger surface area (less weight per square inch) which helps to keep it on top of the snow.

Snowshoes are just one of the technological innovations that humans have developed over time to help them to survive winter. By observing and learning how other organisms cope with winter stresses, humans have been able to continue to develop new techniques and strategies to make our lives easier in northern climates. It will be intriguing to see the discoveries and changes that happen in the next century as more information on the interrelationships between living things and their winter environment come to light.